

**SERVICE MANUAL**  
**SPICER®**

**ES60-5 &  
CM59 SERIES  
TRANSMISSION**



**SPICER®**

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## OPERATION

### Replacement Parts

The exploded views of subassemblies incorporated here are for the mechanic's convenience. The parts are arranged in their correct order and may be used as a reference for the assembly or disassembly of this unit.

### Synchronizer Information

The purpose of a synchronized transmission is to simplify shifting and to help the driver get a clash free shift. To receive these results, however, it is important to understand how the synchronizer works.

When a shift is required, the operator declutches and moves the shift lever toward the desired gear. When the synchronizer ring makes contact with the gear, the blockers automatically prevent the shift collar from completing the shift until the gear and mainshaft speeds are matched. At that time, the blocker automatically neutralizes. The lever moves smoothly and easily into gear.

It takes one or two seconds to match speeds. Steady pressure on the shift lever helps the synchronizer do its job quickly. If the lever is "forced" into gear, it is possible to override a blocker. This defeats the purpose of the synchronizer, however, and can cause gear clash.

Finally, remember that this transmission is not synchronized in first and reverse gears because these gears are normally selected when the vehicle is stationary. No synchronizing of engine speed and road speed is required to get in gear from a stop.

**Caution: Always start in first gear. Starting in any other gear may cause hard shifting and internal transmission damage. This is because a synchronizer needs gear rotation to do its job.**

### Driver Instructions

To begin shifting, first depress the clutch and wait for complete release. Move the shift lever into 1st gear. Next, accelerate to an RPM that will allow enough momentum to select the next higher gear while still allowing vehicle acceleration after the shift has been completed. (There is usually no reason to go all the way to the governor before you shift to second.) The progressive shift technique helps save fuel. This method can vary depending on the GVW of the vehicle, road condition and type of service.

When 2nd gear is desired, declutch and move the lever toward 2nd, keeping steady pressure on the lever. The synchronizer will pick up the gear and synchronize its speed to the mainshaft speed. The lever will move into gear easily.

Continue in the same manner to top road speed. Notice that to have good performance as you approach top road speed, you must accelerate closer to the governed speed before you allow the engine to drop to the next gear shift point. This is because air resistance at higher speeds requires more horsepower. You receive maximum horsepower and performance at governed speed.

When you downshift, use the same procedure. However, the engine must be raised to the governor as the clutch is engaged after completing the shift. To downshift from top gear, declutch as you approach the shift point (the shift usually starts about 100 RPM over the shift point), and move the shift lever with a steady even pressure toward 4th gear. The synchronizer will pick up 4th gear and speed it up to vehicle speed, allowing a clash free shift. After the shift, re-engage the clutch while accelerating to keep the vehicle moving at the desired speed. If further downshifts are required, continue in the same manner.

When downshifting, remember that 1st gear is not synchronized. Double clutching is required to complete a clash free shift. You can double clutch on all other shifts as well. This only aids the synchronizer in doing its job by manually helping to match the engine speed and road speed.

**Caution: Do not tow vehicles equipped with Spicer transmissions without first pulling the axle shafts or disconnecting the driveshaft. Lubrication of the internal gear train is inadequate when the vehicle is towed. Also, do not pull or roll start vehicles in first or reverse gears.**



**Spicer® Transmission Lubrication**

To insure proper lubrication and operating temperatures in these units, it is important that proper lubricants be used and correct oil levels be maintained.

**Recommended Lubricants**

The lubricants listed below are recommended, in order of preference, for use in all Spicer mechanical transmissions, auxiliaries and transfer cases.

DO NOT USE EXTREME PRESSURE ADDITIVES, such as found in multi-purpose or rear axle type lubricants. These additives are not required in Spicer transmissions, and in some cases may create transmission problems. Multi-purpose oils, as a group, have relatively poor oxidation stability, a high rate of sludge formation and a greater tendency to react on or corrode the steel and bronze parts.

**Oil Changes**

We recommend an initial oil change and flush after the transmission is placed in actual service. This change should be made any time following 3000 miles (4827 km), but never exceed 5000 miles (8045 km) of over-the-road service. In off-highway use, the change should be made after 24 hours—but before 100 hours—of service have been completed.

Many factors influence the following oil change periods. Therefore, a definite mileage interval is not specified here. In general, however, it is suggested that a drain and flush be scheduled every 50,000 miles (80,450 km) for normal over-the-highway operations. Off-highway uses usually require an oil change every 1000 hours. The oil level in the transmission should be checked every 5000 miles (8045 km) on-highway, or every 40 hours in off-highway operation. When it is necessary to add oil, we recommend that types or brands of oil not be mixed. The correct oil level in all Spicer transmissions is established by the filler plug opening.

**Refill**

First, remove all dirt around the filler plug. Then refill the transmission with new oil. Use the grade recommended for the existing season and prevailing service. The lubricant should be level with the oil fill plug located on the right side of the transmission case.

**Overfilling**

Do not overfill the transmission. This usually results in oil breakdown due to excessive heat and aeration from the churning action of the gears. Early breakdown of the oil will result in heavy varnish and sludge deposits that plug up oil ports and build up on splines and bearings. Oil overflow escapes onto the clutch or parking brakes, causing additional trouble.

**Towing**

Do not tow vehicles equipped with Spicer transmissions without first pulling the axles or disconnecting the drive shaft. Lubrication of the internal gear train is inadequate when the vehicle is towed.

The following lubricants are recommended, in order of preference.

TEMPERATURE	GRADE	TYPE
Above 0°F (-18°C) Below 0°F (-18°C)	SAE 30, 40, or 50 SAE 30	Heavy Duty Engine Oil meeting MIL-L-2104D or MIL-L-46152 B, API-SF or API-CD (MIL-L-2104 B & C, or 46152 are also acceptable)
Above 0°F (-18°C) Below 0°F (-18°C)	SAE 90 SAE 80	Straight Mineral Gear Oil R & O Type API-GL-1
All	CD SAE 50 CD SAE 30	Synthetic Engine Oil meeting MIL-L-2104 D or MIL-L-46152 B, API-SF or API-CD

Do not use extreme pressure additives, such as found in multi-purpose or rear axle type lubricants. These additives are not required in Spicer Transmissions, and may in some cases create transmission problems. Multi-purpose oils, as a group, have relatively poor oxidation stability, a high rate of sludge formation and a greater tendency to react on or corrode the bronze parts in Spicer Synchronized Transmissions.

## General Precautions for Disassembly

### IMPORTANT

Read this section before starting the detailed disassembly procedure.

Follow each procedure closely in each section, making use of both the text and the pictures.

### Rebuild Facilities

A suitable holding fixture or overhaul stand is desirable, but not necessary, to rebuild this unit. The flat bottom of the transmission case provides a suitable working platform when the unit is placed on a sturdy shop table.

For easier working conditions, table height should be 28-30 inches. A light chain hoist should be used to handle the mainshaft and countershafts during removal and reassembly procedures.

### Cleanliness

Transmissions should be steam cleaned prior to disassembly. Seal all openings before steam cleaning. This will prevent dirt and water entry, which can damage serviceable parts.

Dirt is abrasive and will cause premature wear of bearings and other parts. Therefore, we suggest having a small wash tank nearby so parts can be cleaned prior to reassembly.

### Bearings

When a transmission is removed at relatively low mileage, the bearings should be removed with pullers designed for this purpose. Wrap the bearings to keep out dirt. Clean, inspect and lubricate all bearings just prior to reassembly. If mileage or transmission condition warrants a complete overhaul, it is recommended that all bearings be replaced.

### End Yokes and Flanges

End yokes and flanges should be installed and removed with the correct drivers and pullers—not with a hammer. Hammering is not only destructive to the yoke or the flange, but also can cause serious internal transmission damage. For example, hammering destroys or mutilates the pilot diameters, as well as warps or bends the flange. Hammering on end yokes will close in the bearing bores or misalign yoke lugs, resulting in early journal needle bearing failures.

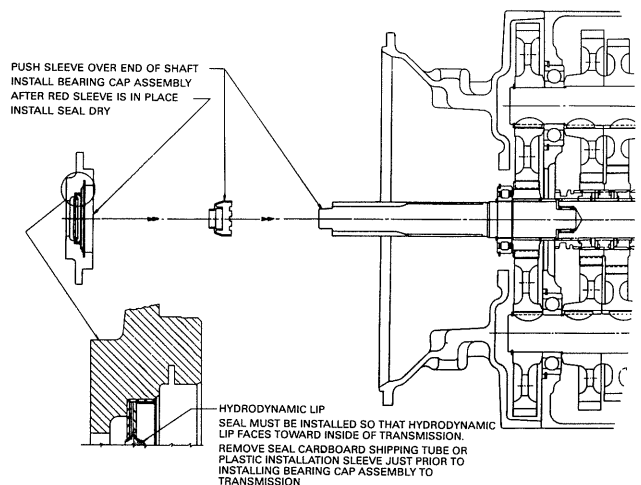
In most designs, when the yoke/flange locknuts are tightened and secure, the internal bearings and gears are in proper location. When the yoke/flange is driven on the shaft, however, two conditions can exist.

- (a) If the bearing fit is *tight* on the shaft, usually the bearings will brinell since they absorb the pounding force of the hammer.
- (b) If the bearing fit is *loose*, the shaft will keep moving inward until it is stopped by the internal parts such as the pilot bearing thrust washers and snap rings.

## INSTALL SEAL DRY

# WARNING

RED SLEEVE MUST BE USED TO PREVENT SERIOUS DAMAGE TO OIL SEAL WHEN ASSEMBLING BEARING CAP. FAILURE TO COMPLY WILL VOID SEAL WARRANTY.



## Shift Tower

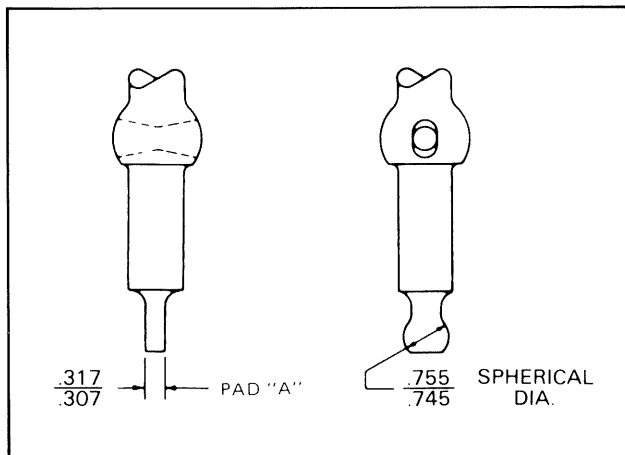
### Disassembly

1. Remove the six retaining capscrews and lockwashers. Separate the dome from the shifter housing and gasket, and lift it straight up.
2. Position the shift lever dome on edge in a vise.
3. Pull up the grommet. Press the collar against the spring, then remove the lock pin.
4. Slide the compression cup up the shift lever and remove the rock shaft snap ring.
5. Tap the rock shaft free of the dome and remove the shift lever. Now remove and discard the gasket.
6. Remove the shift lever handle and slide the grommet, collar, spring and cup off the lever.

4. Assemble the rock shaft snap ring to the groove of the dome, locking the rock shaft in place.
5. Next place a new, lightly greased seal on the shift dome. Grease the inner wall of the cup, and slide it over the lever into position on the dome.
6. Assemble the spring, collar and grommet over the shift lever. Depress the collar and insert the collar lock pin through the hole in the lever.
7. Assemble the shift lever handle.
8. Place the shift lever and dome assembly on the shifter housing with a gasket, noting that the finger enters the neutral position notches.
9. Secure the assembly with the capscrews and lockwashers.

### Inspection

Wash all parts thoroughly and inspect the lever and rock shaft cross holes for excessive wear.

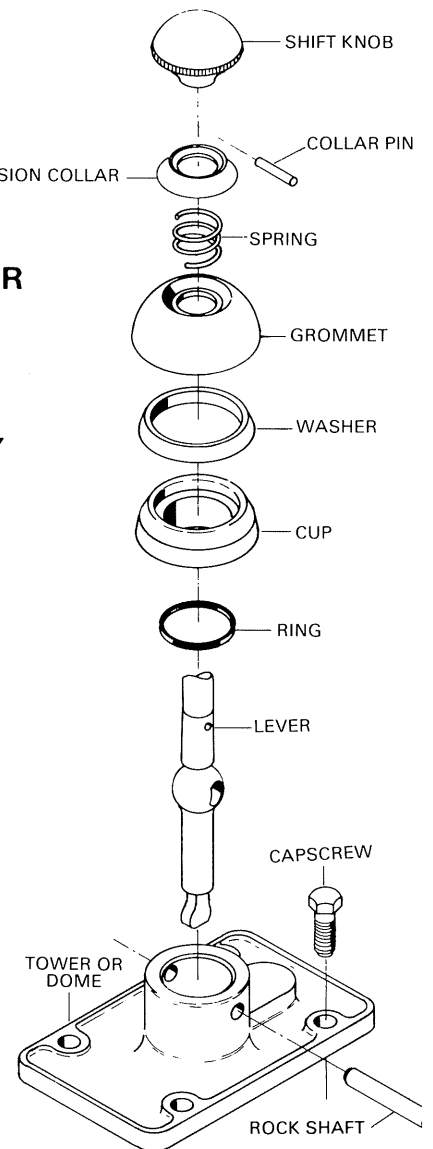


Check the spring tension by comparing the old spring to a new one.

### Reassembly

1. Position the shift lever dome on edge in a vise.
2. Hold the shift lever so that the lever cross hole aligns with the rock shaft cross hole in the dome.
3. Insert the rock shaft through the holes in the dome and shift lever.

### SHIFT LEVER AND TOWER ASSEMBLY



## Remote Control

### Disassembly

1. Remove the six capscrews and lockwashers. Separate the remote control from the shifter housing.
2. Remove the setscrew from the universal joint assembly, and pull the universal joint from the rod.
3. Remove the four capscrews and lockwashers that hold the end cover and gasket in place.
4. Remove the setscrew from the joint shift rod finger. Tap the rod through the cross holes in the housing.
5. Remove the finger from the housing.
6. Remove the setscrew from the inner shift finger.
7. Slide the rod and bracket assembly from the inner shift finger. Be careful not to lose the key.
8. Remove the seals from the cross holes in the housing.

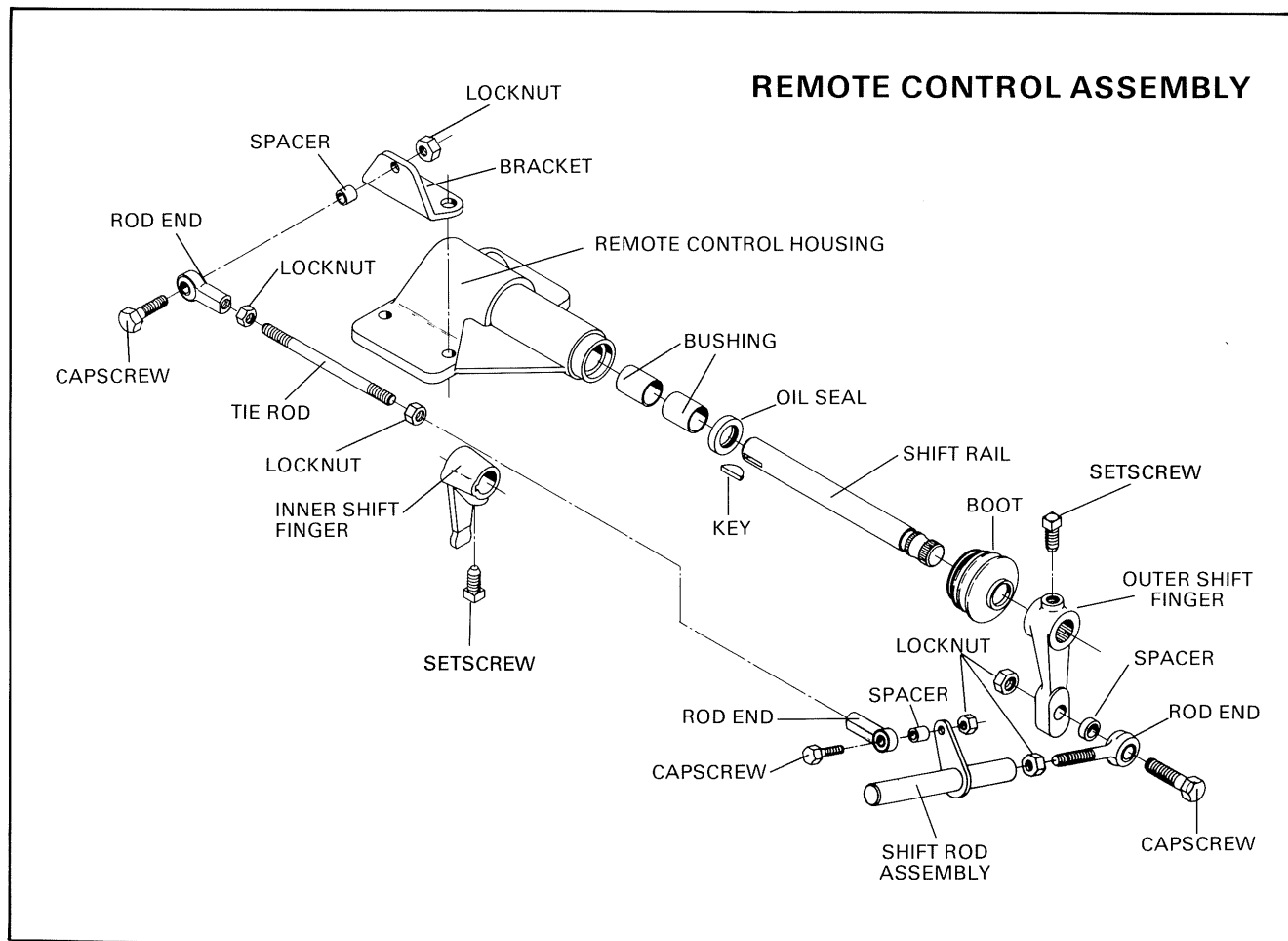
### Inspection

Check the shift fingers for excessive wear. Also check all bores and rods for excessive wear or scuffing.

Clean all parts thoroughly, and apply a light coat of grease to the pivot points when reassembling.

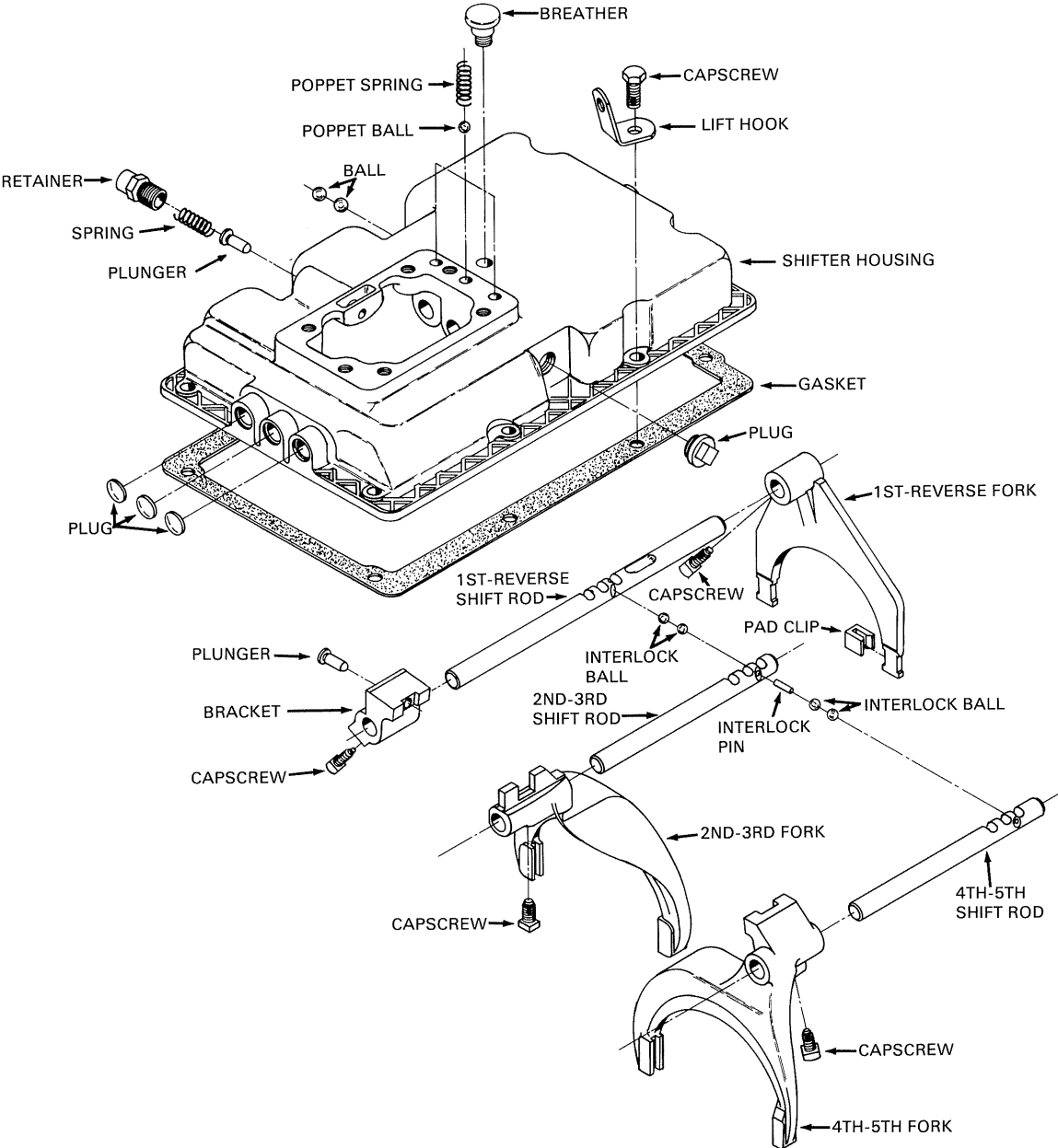
### Reassembly

1. Install a key in the rod and bracket assembly. Install the unit into the remote housing, sliding the inner shift finger on the end of the rod.
2. Line up the setscrew hole and install the setscrew. Torque to 40-50 ft. lbs.
3. Install the joint shift rod through the cross holes and the outer finger. Make sure the finger is inserted into the bracket.
4. Align the setscrew hole and install the setscrew. Torque to 40-50 ft. lbs.
5. Install the end cover, and secure it with the four capscrews and lockwashers.
6. Install two new oil seals in the joint shift rod bores.
7. Install the joint assembly and secure it with a setscrew.



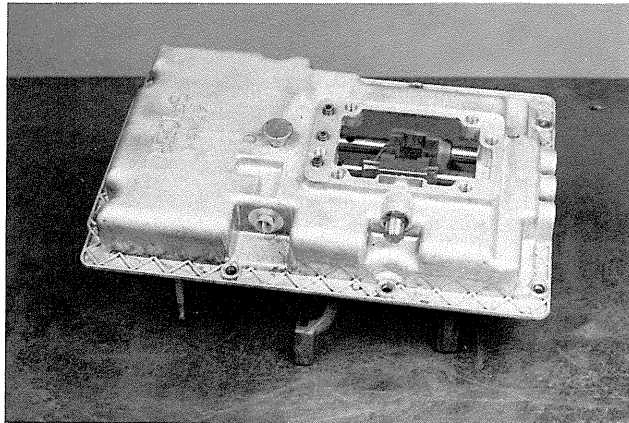
# SHIFTER HOUSING

# SECTION IV

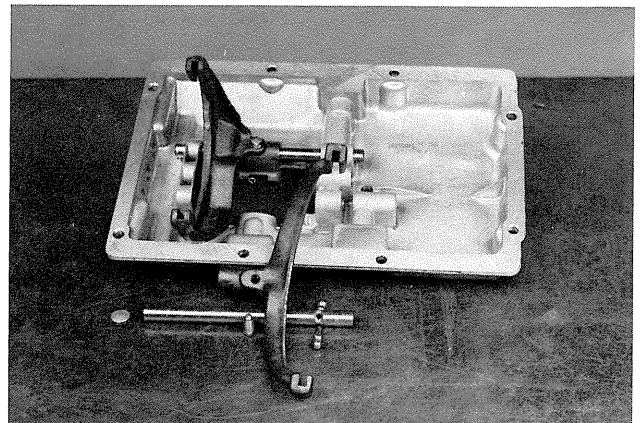


# SHIFTER HOUSING DISASSEMBLY

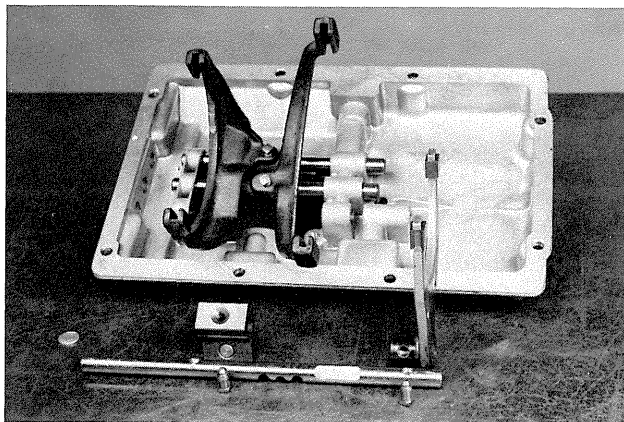
# SECTION IV-A



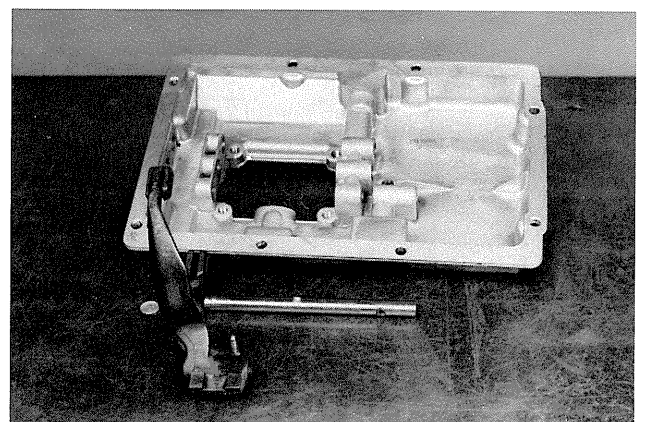
1. Remove the shifter housing and place it on a bench.



3. The 2nd-3rd speed shift fork may be removed. Do not lose the interlock balls or the interlock pin located in the shift rod.



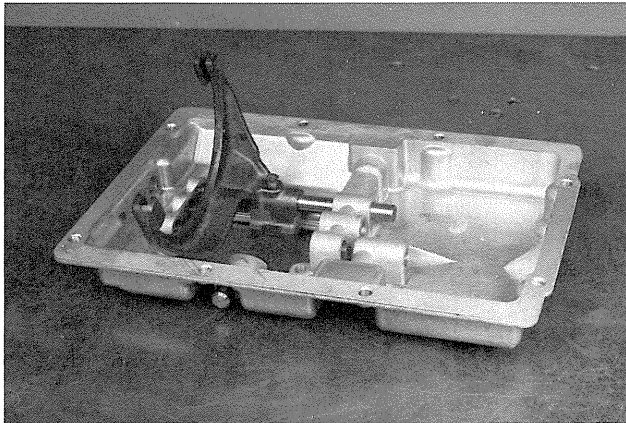
2. Now, remove the 1st-reverse shift fork and shift bracket.



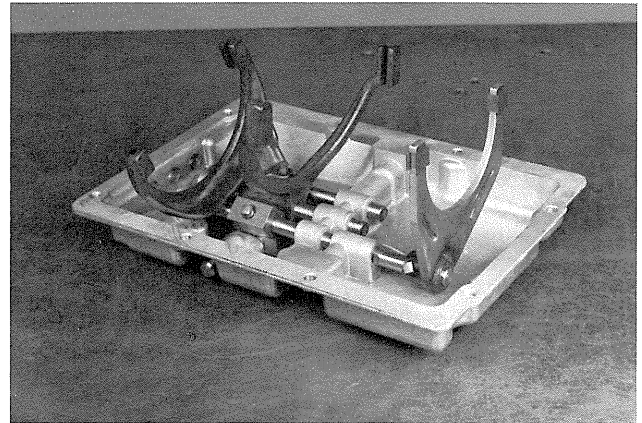
4. All that remains is the 4th-5th speed shift fork. Examine all the fork pad clips and the shift rods for excessive wear prior to reassembly.

# SHIFTER HOUSING REASSEMBLY

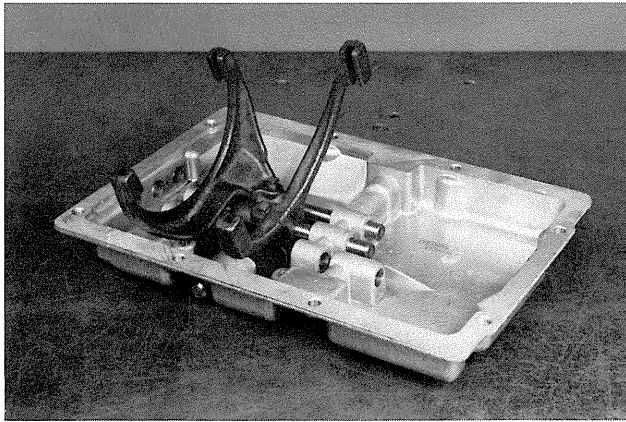
# SECTION IV-B



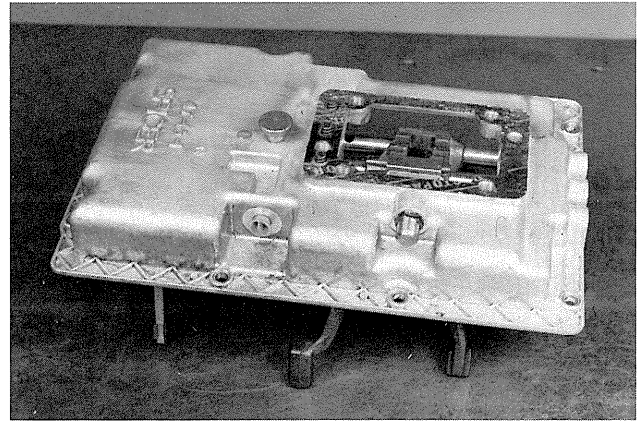
1. Begin the reassembly by installing the 4th-5th speed shift fork.



3. Next, install the 1st-reverse shift fork with pad clips and the shift bracket.



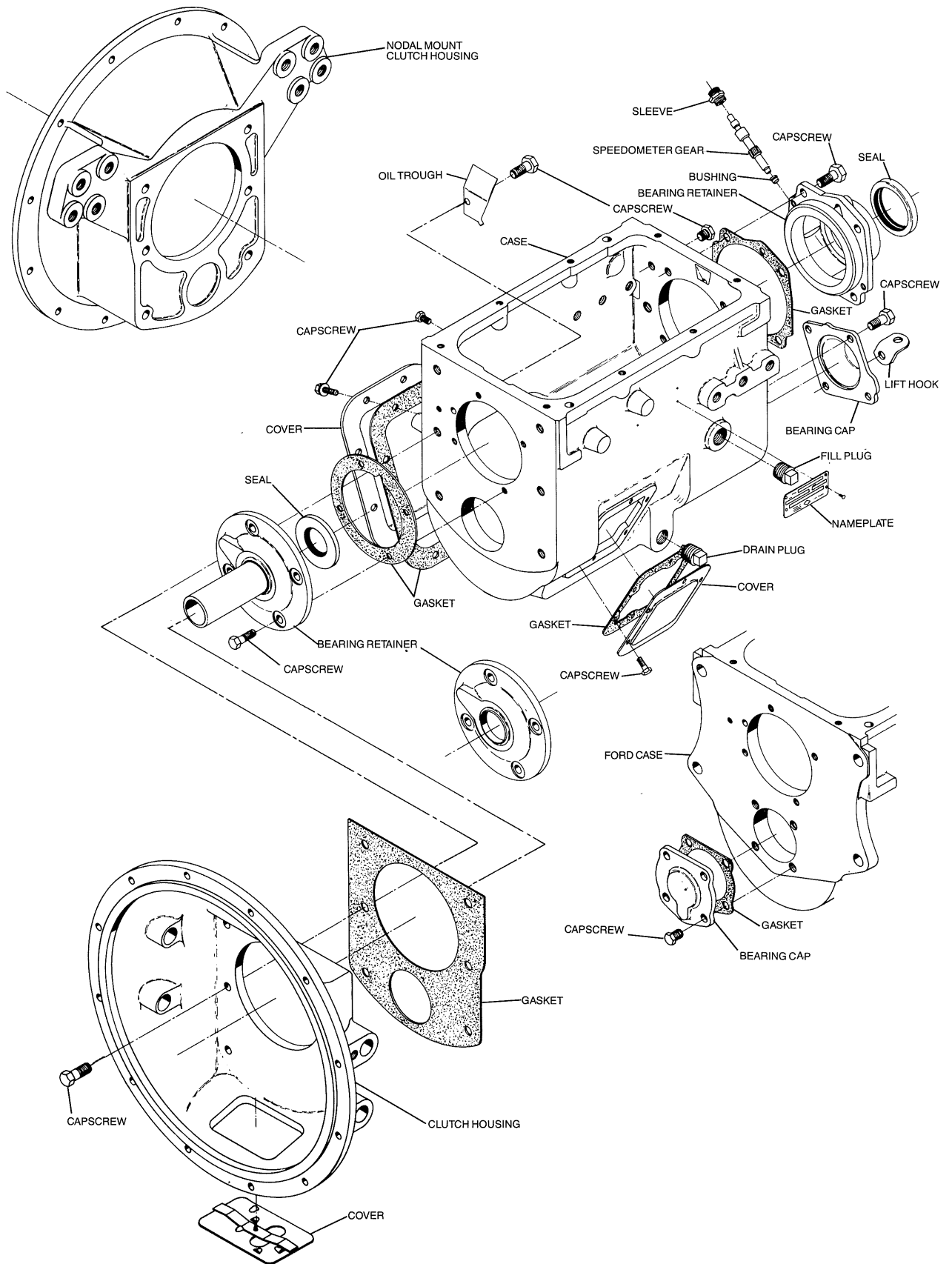
2. Install the 2nd-3rd speed shift fork and place all the interlocks into their proper position.



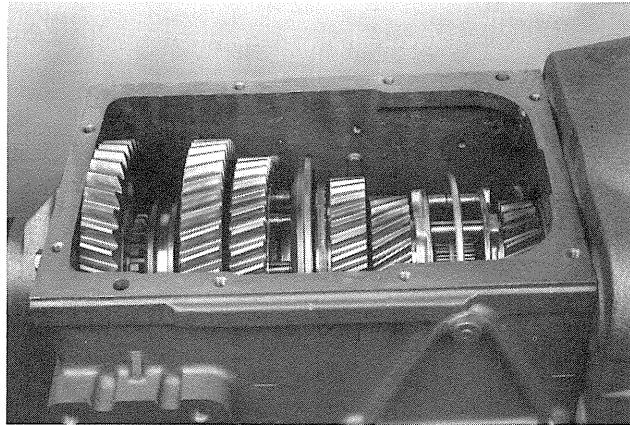
4. Finally, place all the poppet balls and poppet springs into the housing.

# CASE SUBASSEMBLY

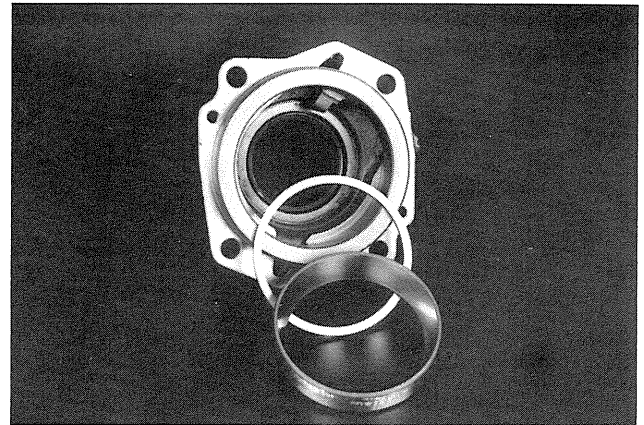
# SECTION V



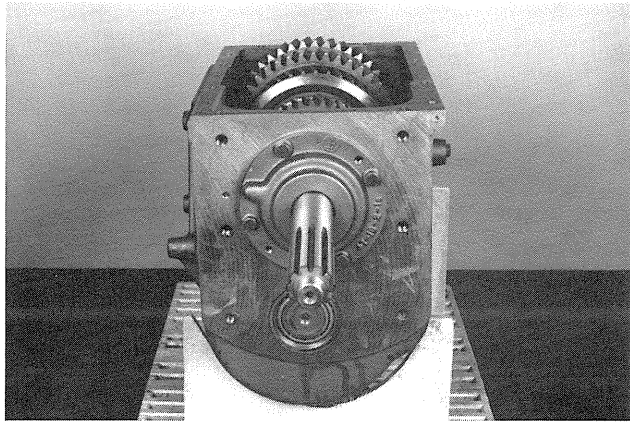




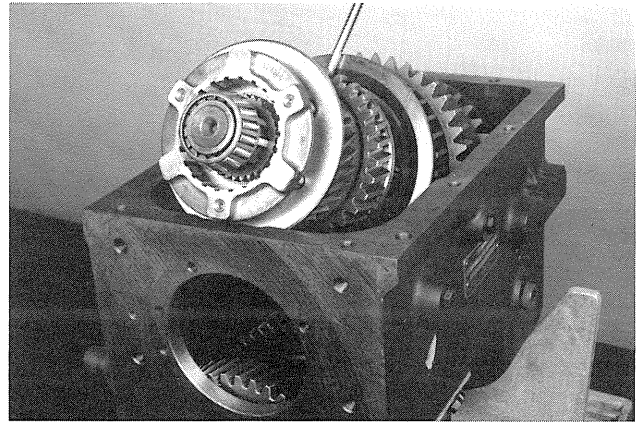
1. Remove the shifter housing.



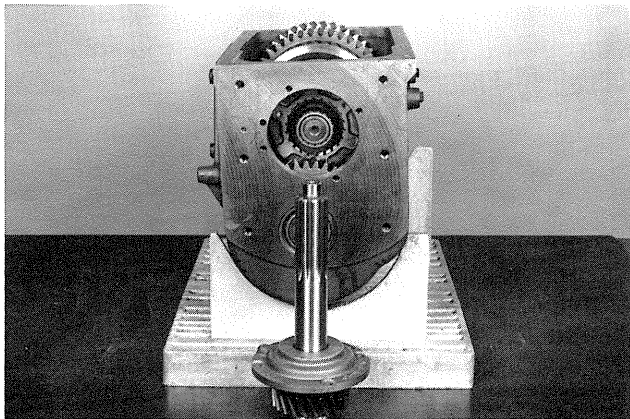
4. The output bearing cap and gasket should be removed next. Note that mainshaft end play is adjustable through a spacer and shims in this output bearing cap.



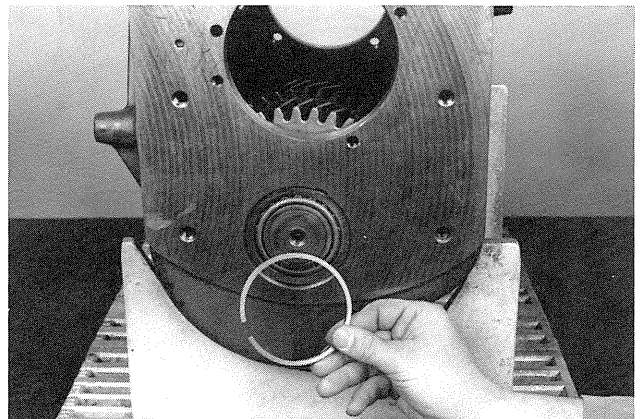
2. Continue by removing the clutch housing.



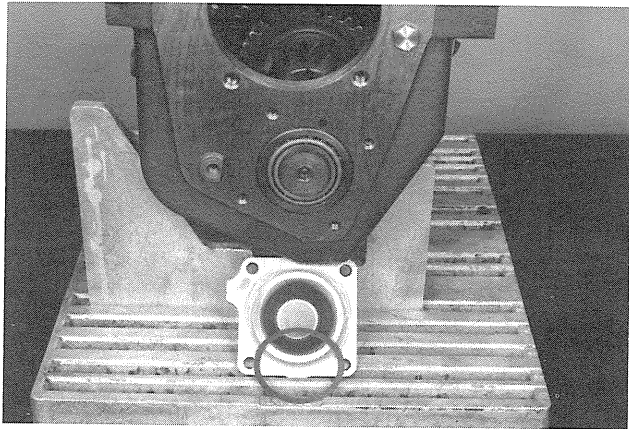
5. Lift the mainshaft subassembly from the case.



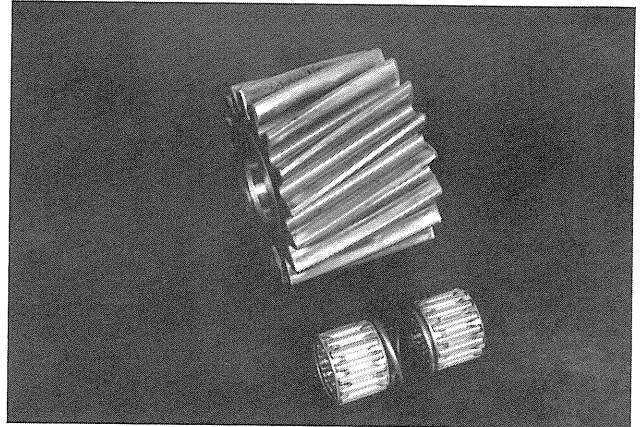
3. Remove the input bearing cap and the input gear.



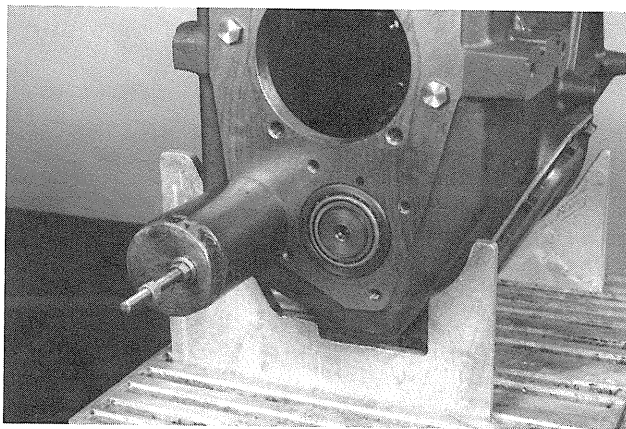
6. Remove the countershaft lubrication spacer from the case bore.



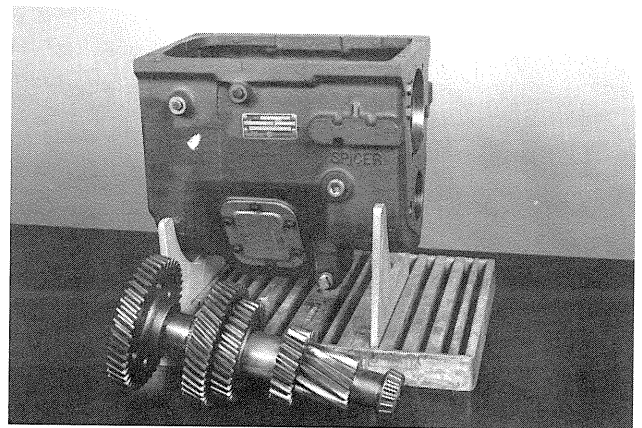
7. Now remove the countershaft rear bearing cap and shims.



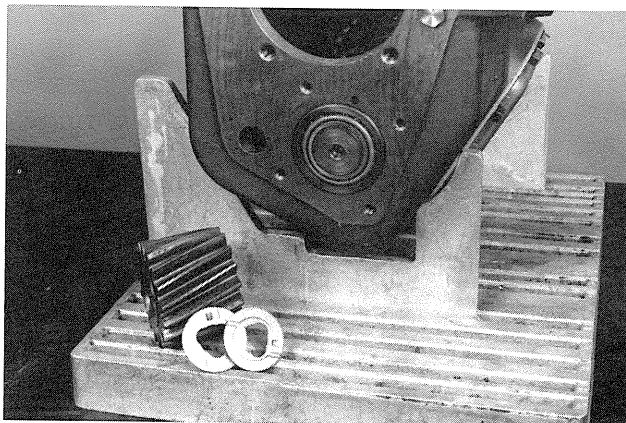
10. This idler gear contains two bearings and a spacer in its bore.



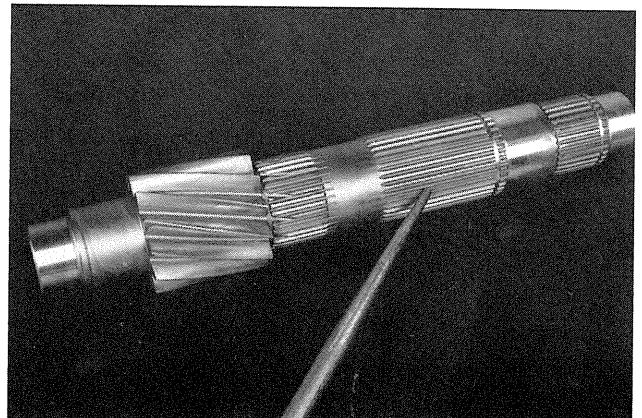
8. The reverse idler shaft may be removed. Kent Moore puller J-28668 is recommended.



11. The countershaft subassembly may be removed now.



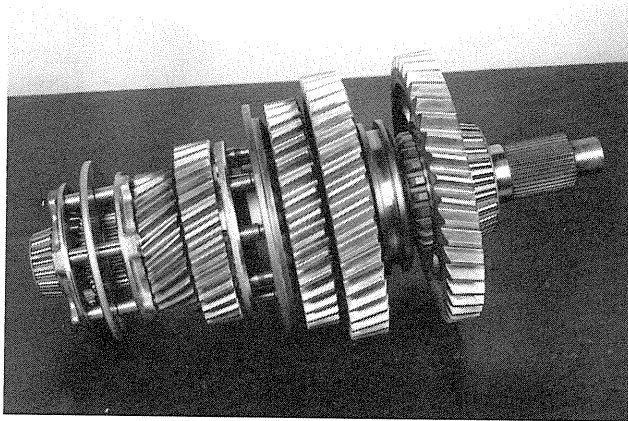
9. Lift the reverse idler gear and thrust washers out of the case.



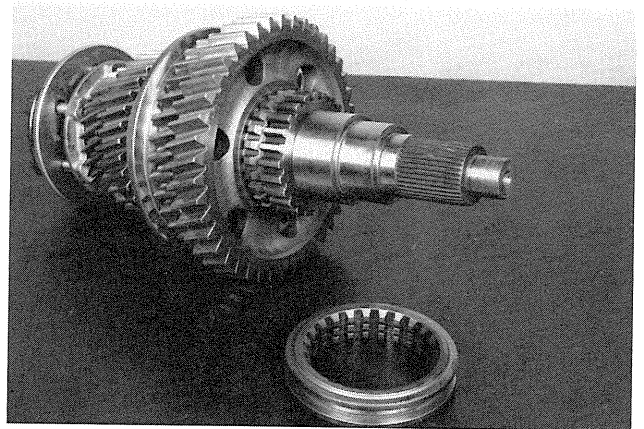
12. Rolled involute splines secure the countershaft gears.



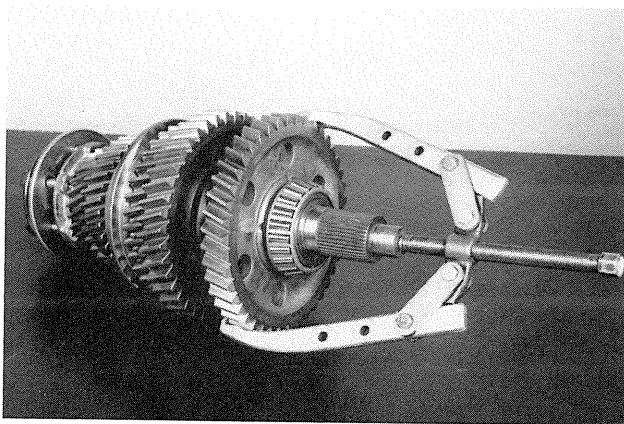




1. Place the mainshaft subassembly on a bench.

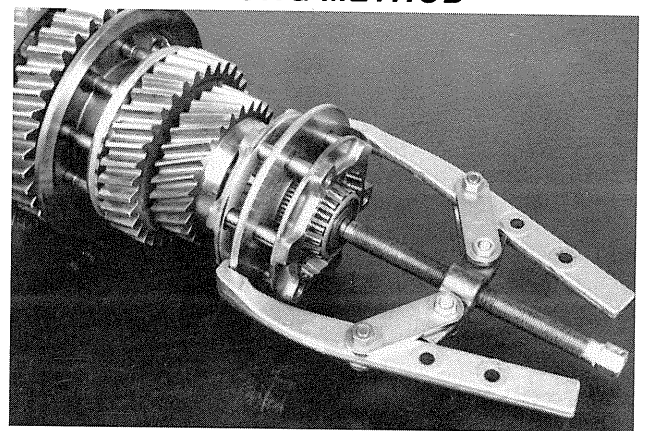


4. Remove the 1st-reverse clutch collar.



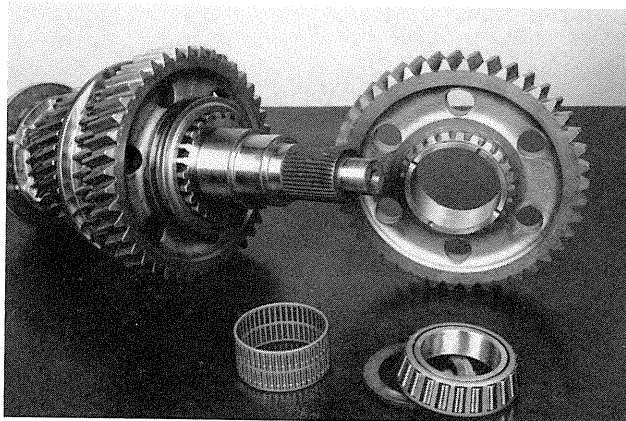
2. Use a suitable puller to remove the output bearing.

## WRONG METHOD

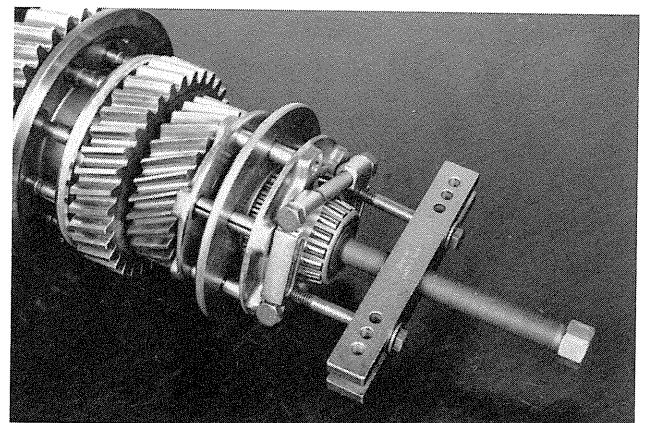


## CAUTION:

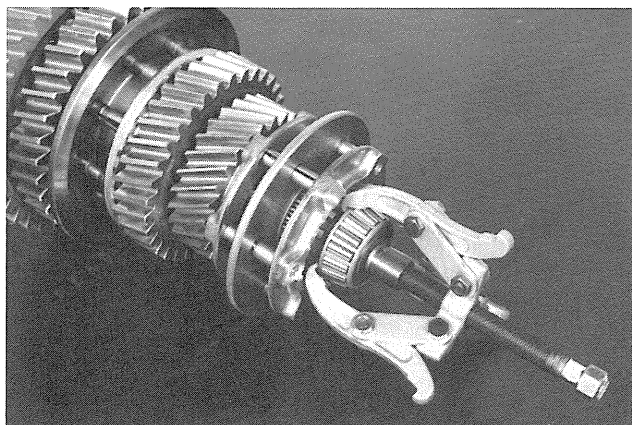
5. Due to the synchronizer's design, do not place a puller on it in an attempt to remove the input pocket bearing.



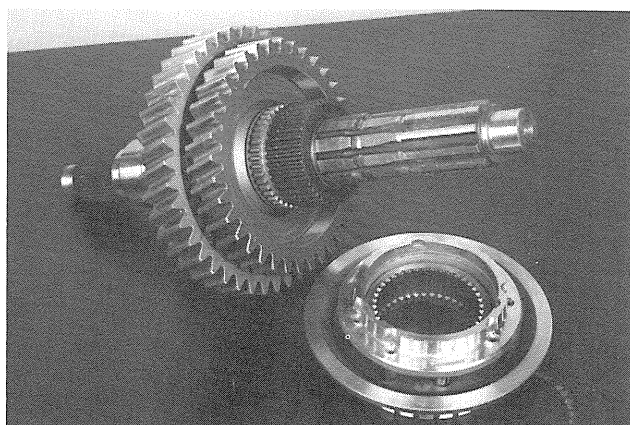
3. This method insures safe removal without bearing damage.



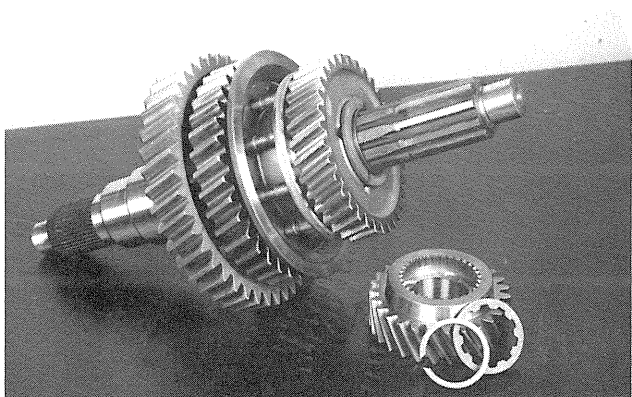
6. One of these methods should be used to remove the pocket bearing from the mainshaft pilot diameter.



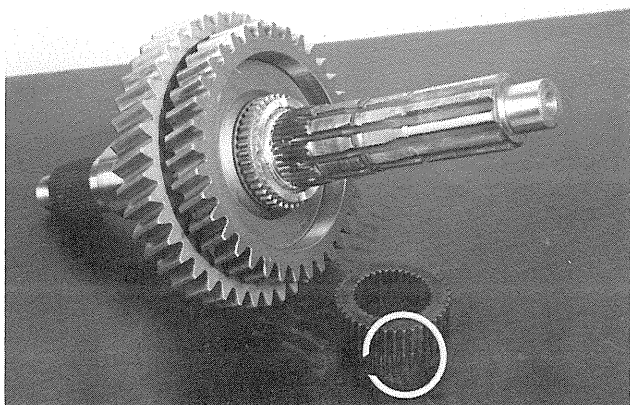
7. Alternate method for bearing removal.



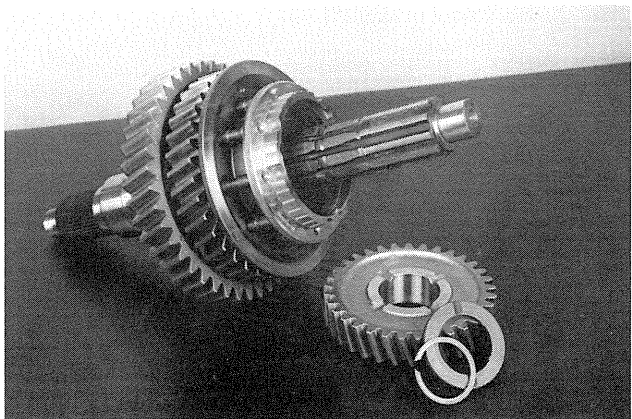
10. The 2nd-3rd speed synchronizer may be removed.



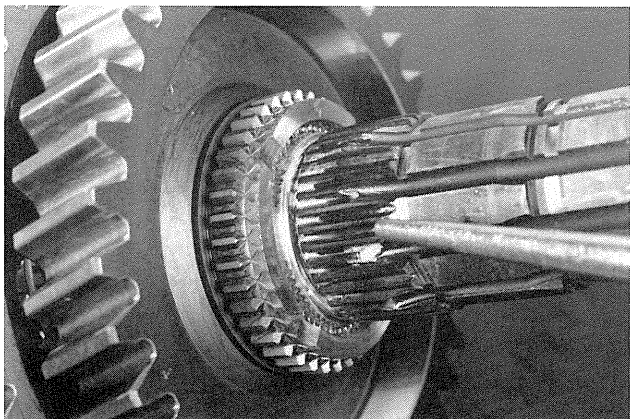
8. After removing the snap ring, the 4th speed gear and washer may be lifted from the mainshaft.



11. Remove the snap ring and the 2nd-3rd speed clutch gear.



9. Remove the 3rd speed gear, thrust washer and snap ring.

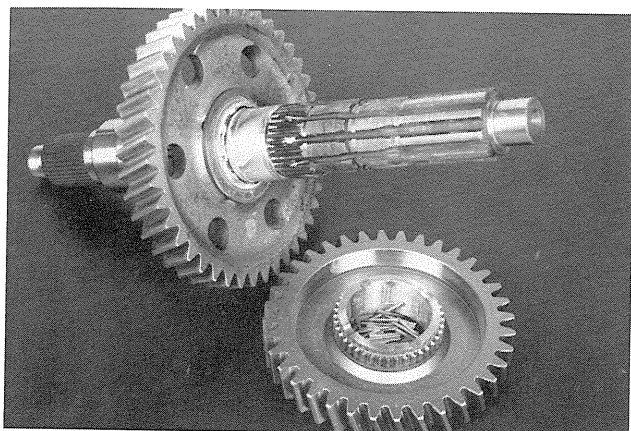


12. Rolled involute splines provide easier disassembly and reassembly.

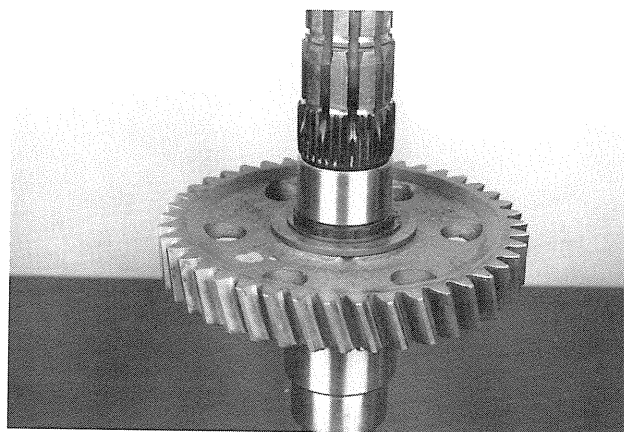


# MAINSHAFT DISASSEMBLY & REASSEMBLY

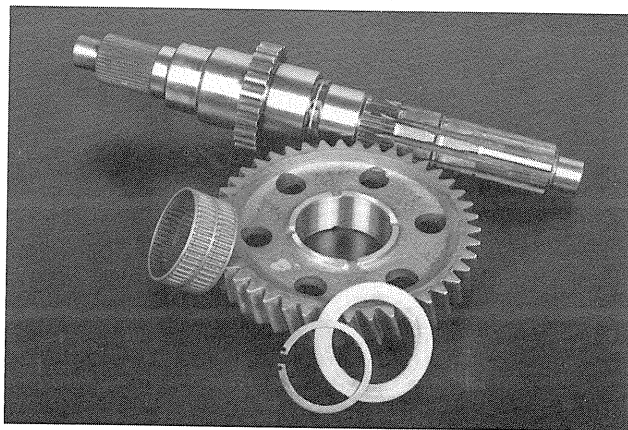
# SECTION VI-A



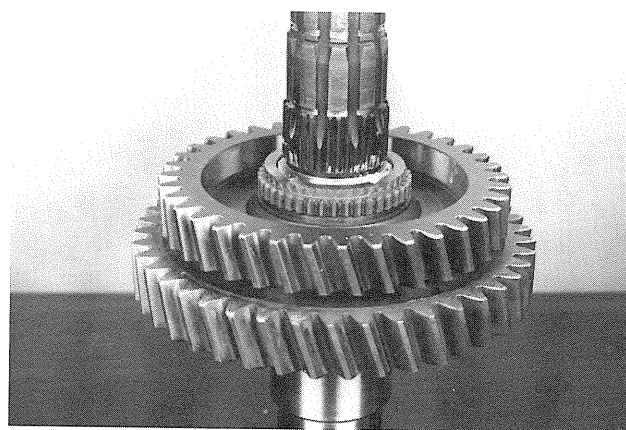
13. The 2nd speed gear contains loose needle bearings in its bore. They are used to meet the required load capacity of the 2nd speed gear.



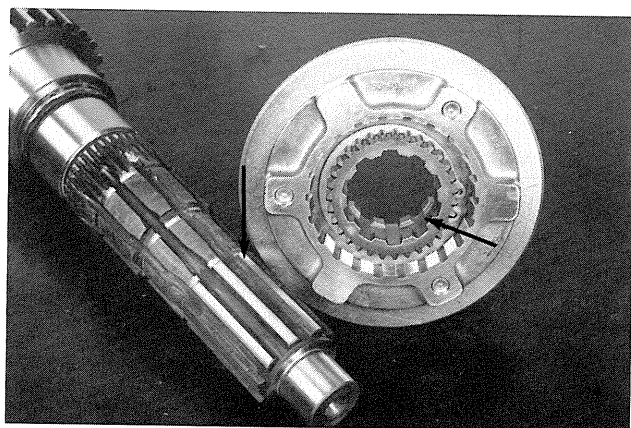
16. Mainshaft reassembly begins by placing the 1st speed gear and thrust washer on the mainshaft. Secure them with a snap ring.



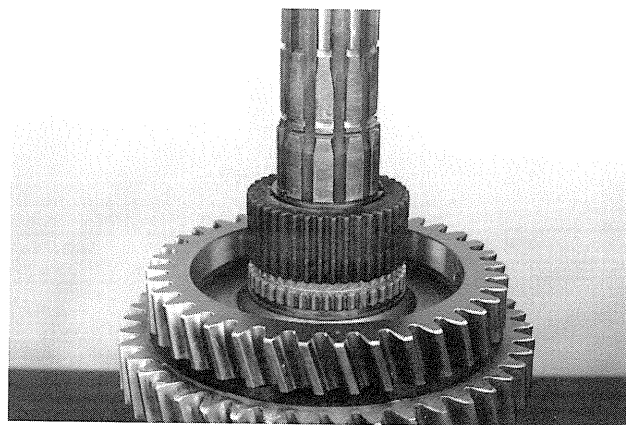
14. Remove the snap ring and 1st speed gear with the thrust washer and caged needle bearing.



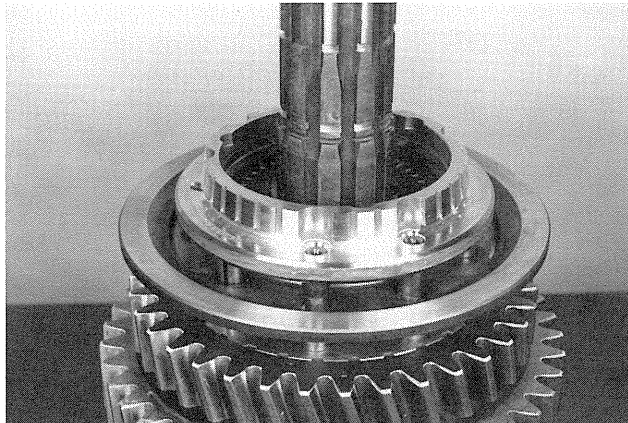
17. Place the 2nd speed gear on the mainshaft, over two rows of loose needle bearings.



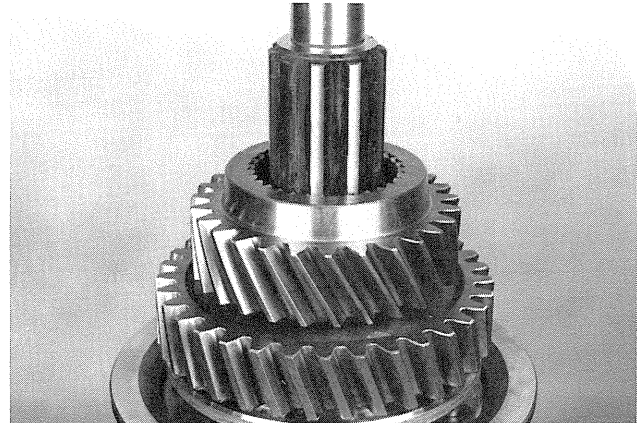
15. Examine the mainshaft gearlocks and the internal corners of the synchronizer clutching teeth for excessive wear that could produce gear jumping.



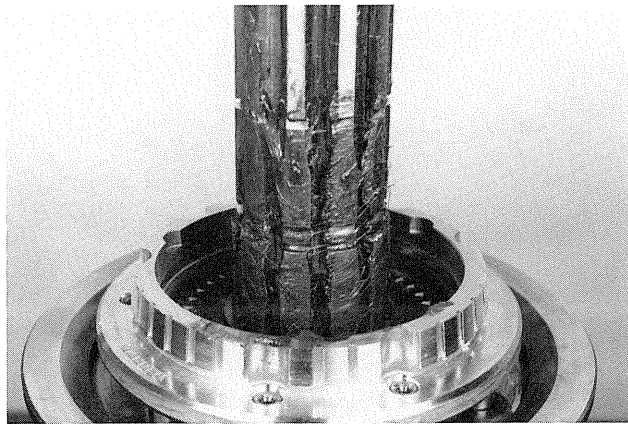
18. Install the 2nd-3rd speed clutch gear and secure it with a snap ring.



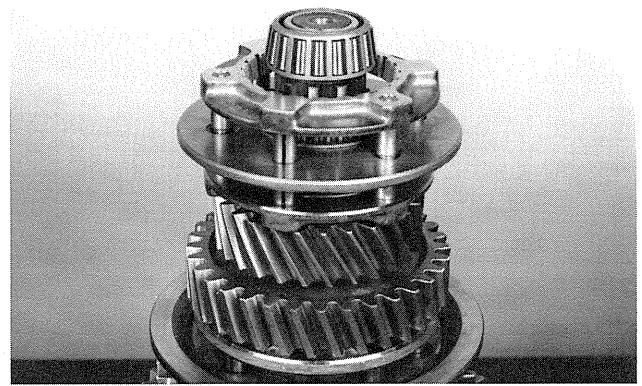
19. Place the 2nd-3rd speed synchronizer over the clutch gear.



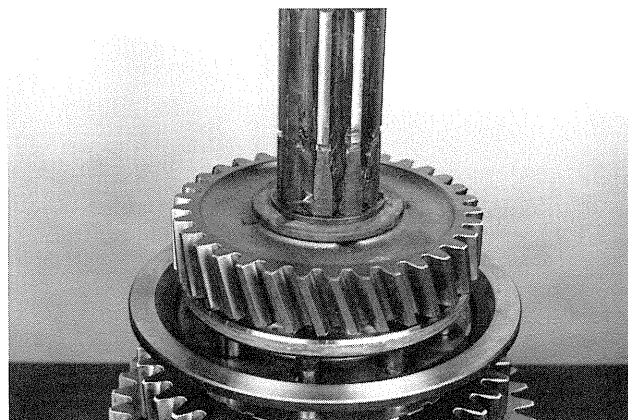
22. The 4th speed gear, complete with thrust washer, may be assembled to the mainshaft. Again, secure with a snap ring.



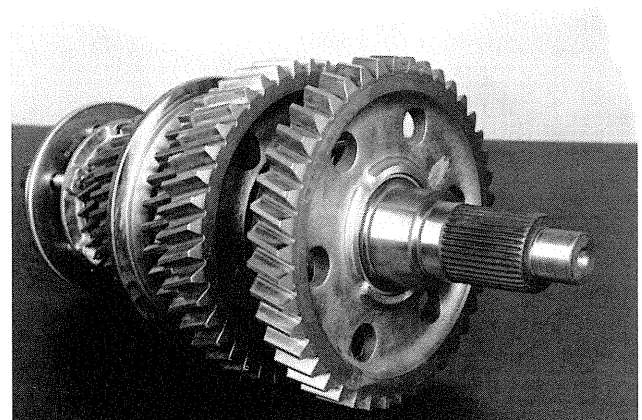
20. All fluted diameters should be coated with Moly #2 lube.



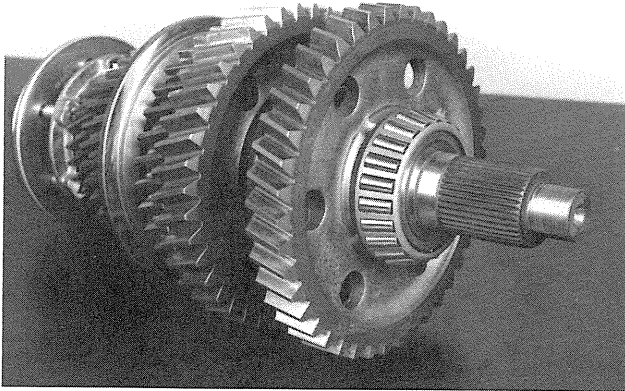
23. Place the 4th-5th speed synchronizer on the mainshaft. Then use a suitable driver to install the pocket bearing.



21. Assemble the 3rd speed gear and thrust washer. Secure them with a snap ring.



24. Set the mainshaft on a bench and install the 1st-reverse clutch collar and reverse gear with a caged needle bearing.



25. The output bearing must be seated firmly against the reverse gear thrust washer, so that the washer does not move.



## Inspection

Prior to reassembling the mainshaft, certain individual parts should be examined. Parts damaged from previous service should be eliminated to insure maximum rebuild life.

These suggested inspection procedures should be followed:

**Clutch Collars:** Both the internal and external teeth must have sharp edges. Rounded corners or excessive chipping will cause gear jumping. Also, examine fork slots for wear.

**Gears:** Examine for broken or cracked operating teeth. Also, check for any unusual wear patterns. Clutching teeth must not show excessive wear.

**Thrust Washers:** Check for flatness or excessive face wear (cracks, scoring, etc.)

**Snap Rings:** Examine for distortion or loss of tension. New snap rings are recommended with every rebuild.

**Mainshaft:** Check spline gearlocks for sharp corners. Worn or ironed out gearlocks will produce gear jumping. Also, check for chipped splines at snap ring grooves.

## TORQUE SPECIFICATIONS FOR NUTS AND CAPSCREWS

NOM. THREAD SIZE (DIA.)	PART NAME	WRENCH TORQUE FT. LBS.			
		NON-LOCKING TYPE		LOCKING TYPE (Bonded Nylon Patch)	
		MIN.	MAX.	MIN.	MAX.
.250 6	Cap Screw or Nut	7	10	10	13
.312	"	13	17	20	24
.375 10	"	25	32	34	41
.438	"	40	50	52	62
	"			60	80
.500	"	60	80	78	98
	"			80	100
.562	"	90	115	112	137
.625	"	120	150	150	180
.750	"	200	250	240	290
1.250	Nut			500	550
1.375	"			550	600
1.750	"			550	600
	<b>PTO Aperature Cover Capscrews</b>				
.375	Capscrew	10	15	16	24
.438	Capscrew w/Gasket 97-324-2	20	25	36	41
.438	Capscrew w/Gasket 22P22	20	25	29	34
	<b>Shift Fork Or Bracket Set Screws</b>	<b>Lockwire Type</b>			
.375	Set Screw	25	32	34	41
.436	"	25	32	34	41
.438	"	40	50	52	62
	<b>Idler Cover</b>	<b>Self Tapping</b>			
10		25	32		

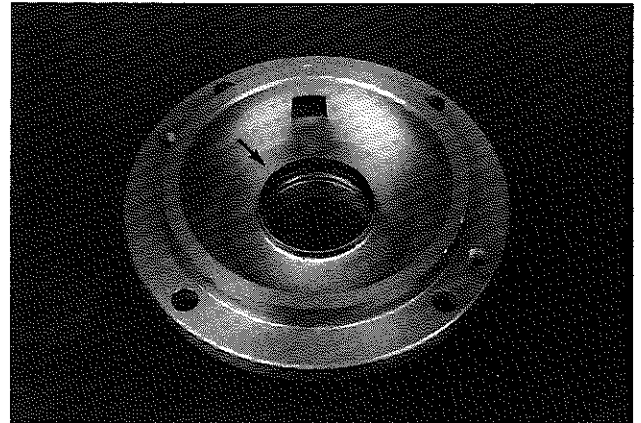
On all transmissions with .750-14 NPTF drain plugs, the drain plug torque should be 50-65 ft. lbs. The only exceptions are the ES42-5, ES52-5, CM40, CM49 and CM55 Models. The torque on these units should be 30-45 ft. lbs.

# INPUT GEAR DISASSEMBLY & REASSEMBLY

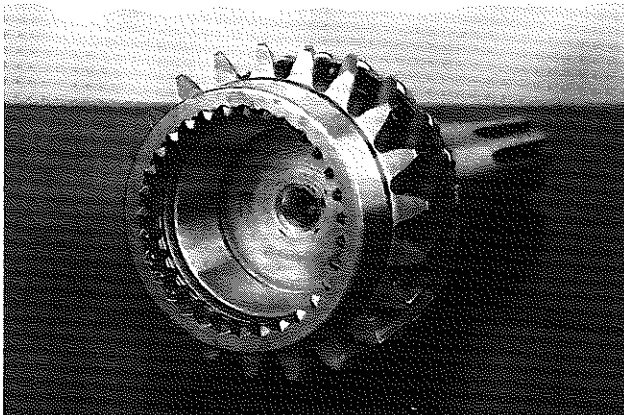
# SECTION VII



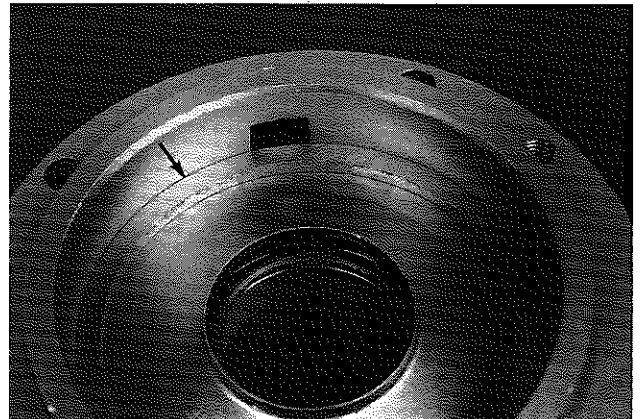
1. This input section provides the same lubrication system as the CM 55.



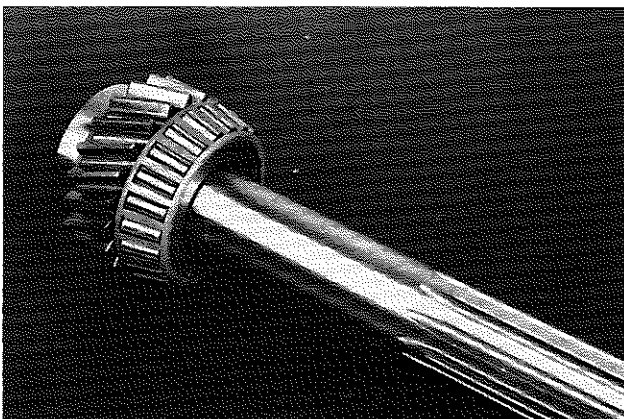
4. Place the baffle into the input bearing cap.



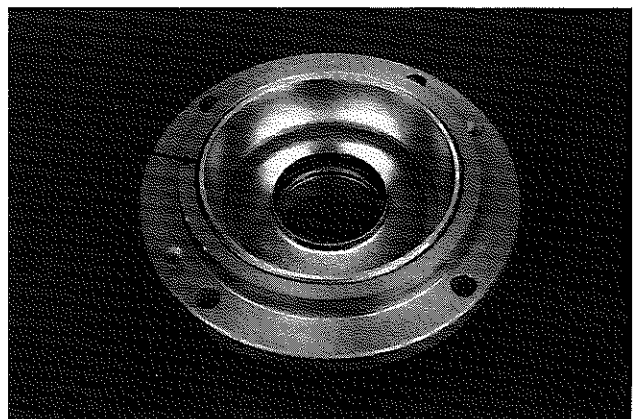
2. An axially drilled hole allows lubricant to flow to the pocket bearing.



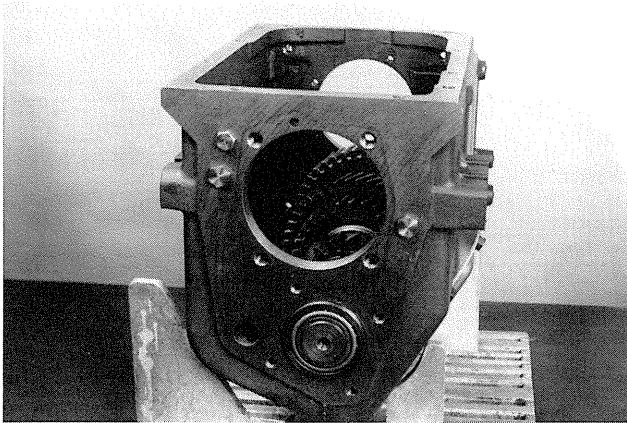
5. Next install the spacer.



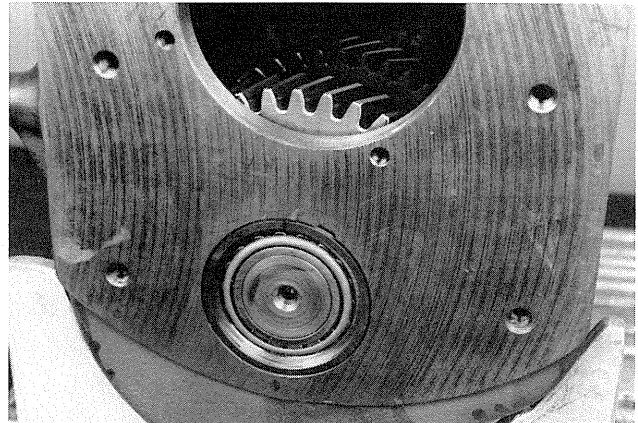
3. The input gear baffle is recessed into the input bearing to form a dam.



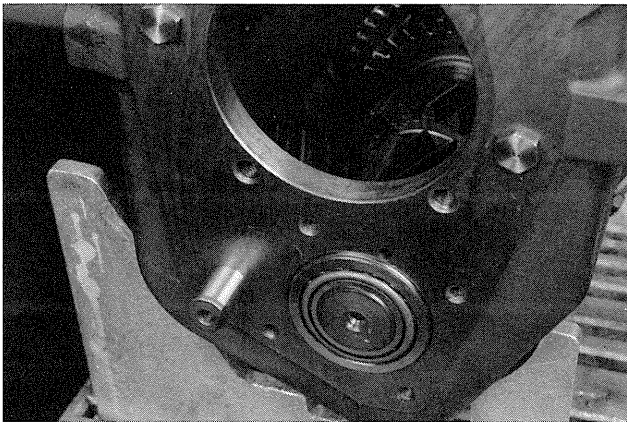
6. Insert the bearing race.



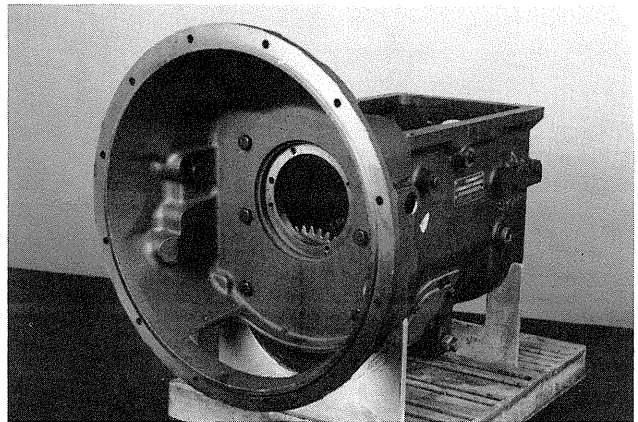
1. Place the countershaft subassembly into the case.



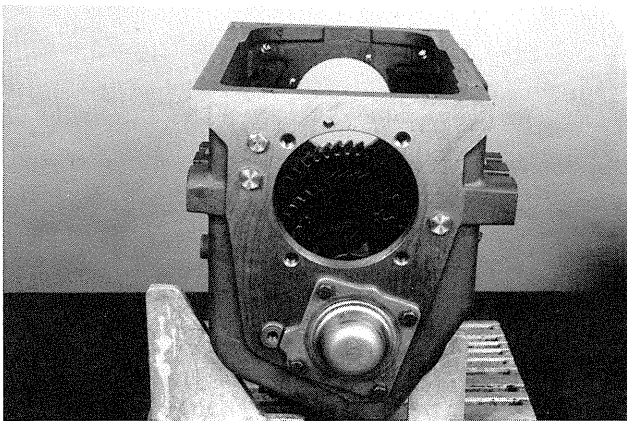
4. Install the lubrication spacer into the countershaft front bearing bore.



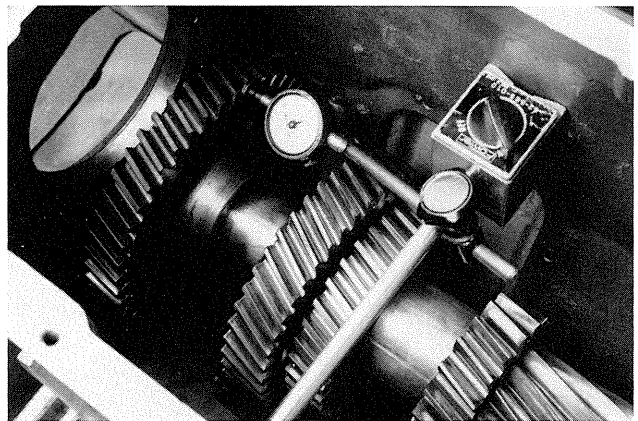
2. Position the reverse idler gear and thrust washers in the case. Then, install the idler shaft with the flat side facing the bearing cap.



5. Assemble the clutch housing and gasket to the case.



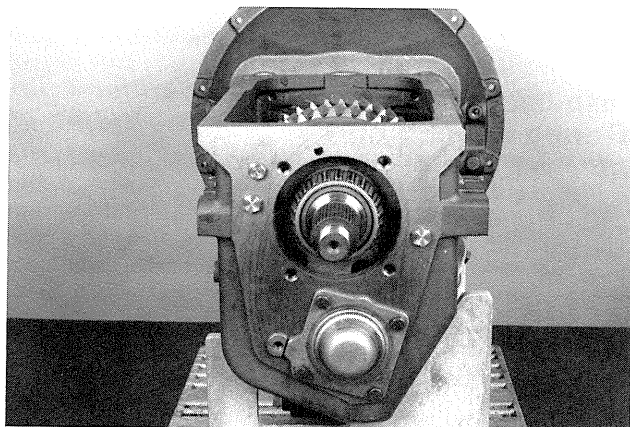
3. Assemble the countershaft rear bearing cap, gasket and shims.



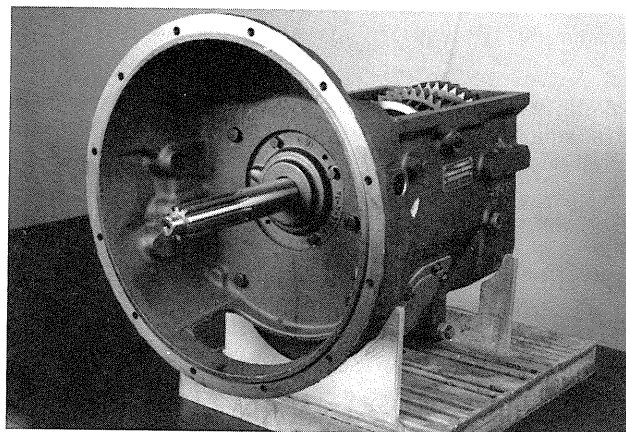
6. Check the countershaft end play. **End play must be set between .001" to .008"**. Adjustments can be made by re-shimming if necessary.

# GEAR & CASE REASSEMBLY

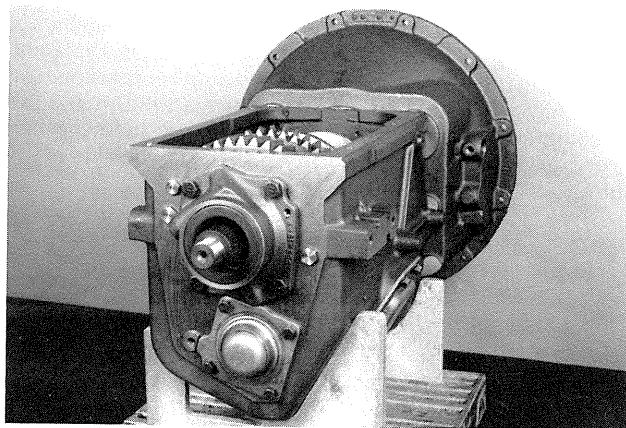
# SECTION VIII



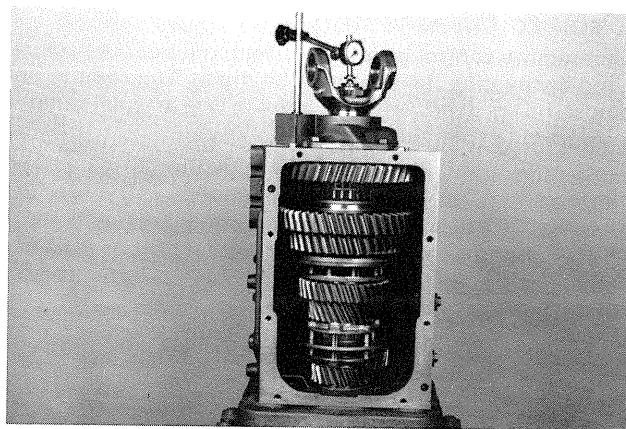
7. Lower the mainshaft subassembly into the case.



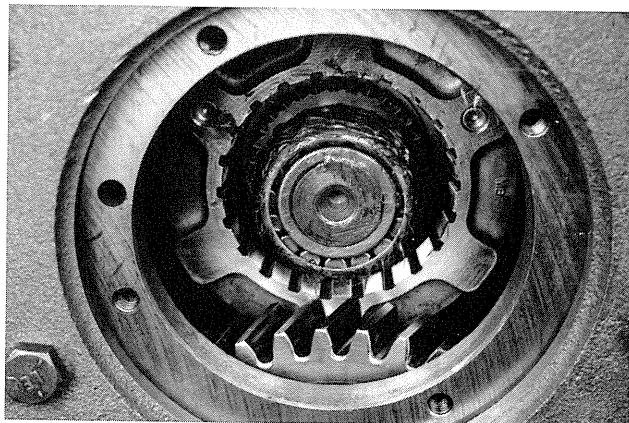
10. Install the input gear bearing cap and gasket. Secure them with capscrews. **Torque to 34-41 ft. lbs.** See page 5 for seal installation.



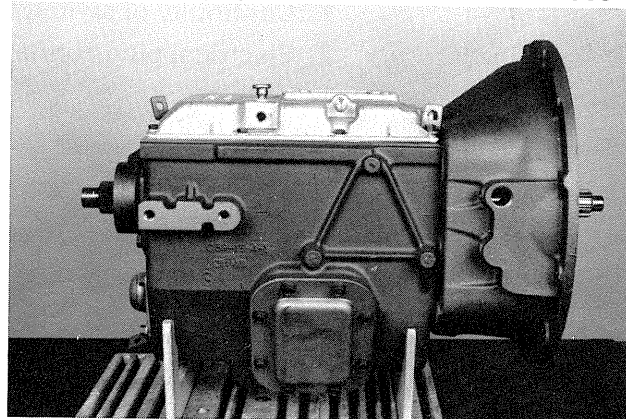
8. Install the output bearing cap and gasket. Remember, mainshaft end play is controlled by the spacer and the shims under the loose bearing race in this cap.



11. Now stand the transmission upright to check the mainshaft end play. First assemble the end fitting and secure it with a washer and nut. **Torque to 500-600 ft. lbs.** Rotate the mainshaft to properly seat the bearings. Then place a dial indicator on the output end of the shaft and lift the mainshaft with pry bars. **End play must be set between .003" - .008"**.



9. Pre-lube the input pocket bearing with a Moly #2 lubricant.



12. Set the transmission back into a horizontal position and place all collars in neutral. Install the shifter housing and gasket. Secure them with capscrews, and **torque to 20 - 30 ft. lbs.**



## Important Procedure

When locating and correcting unit power or auxiliary transmission troubles, a systematic procedure should be followed.

*Road test* whenever possible. Mechanics usually get second or third hand reports of trouble experienced with the unit. These reports do not always accurately describe the actual conditions. Sometimes symptoms seem to indicate trouble in the transmission, while actually the problem is with the axle, driveshaft, universal joints, engine or clutch. This is especially true of noise complaints. Therefore, before removing the transmission or related components to locate trouble, road test to check the possibility of trouble in other closely associated units. Road testing is most effective when the mechanic himself drives the vehicle. However, riding with the driver can be very informative.

### Check Functioning Prior to Disassembly

If a remote control is used, a careful check of the remote and connecting linkage must be made. The remote unit must be in good working order if the transmission is expected to shift satisfactorily.

Many times, the answer to the trouble is apparent when the unit is inspected prior to disassembly. But this evidence is often lost when the parts are separated. If possible, check the unit prior to disassembly. Bear in mind that a careful inspection of the unit should be made as each disassembly step is performed.

### Inspect Thoroughly During Disassembly

It is poor practice to disassemble a unit or the complete transmission as quickly as possible without examining the parts. The mechanic may completely disassemble a unit and fail to find the cause of the trouble, unless he examines the parts. After the transmission is disassembled, check the lubricant for foreign particles. This is a source of trouble often overlooked during the disassembly.

### Repair or Replace Worn Parts

Many times the parts or critical adjustments causing the trouble are not replaced or corrected because the mechanic only inspects and replaces parts that have failed completely. *All* pieces should be accurately examined because broken parts are often just the result—not the cause—of the problem. All parts that are broken or worn and no longer meet specifications should be replaced.

Also, parts that are worn to the extent that they do not have a long service life remaining should be replaced. Replacing these parts now will avoid another teardown on the unit in the near future. Also at this time, make the recommended changes or modifications to bring the transmission up to date and increase the service life of the unit.

**CAUTION:** If the backup lights do not function, check the following:

1. Continuity of switch with ball fully depressed
2. Electrical plug connection
3. Wiring


**Noisy Operation**

Noise is usually a very elusive problem, and is generally not the fault of the transmission. Mechanics should road test the vehicle to determine if the driver's complaint of noise is actually in the transmission.

In numerous instances drivers have insisted noise was coming from the transmission, investigations revealed it was caused by one of the following conditions:

- (a) Fan out of balance or blades were bent.
- (b) Defective vibration dampers.
- (c) Crankshaft out of balance.
- (d) Flywheel out of balance.
- (e) Loose flywheel mounting bolts.
- (f) Rough engine idle producing rattle in gear train.
- (g) Clutch assembly out of balance.
- (h) Loose or broken engine mounts.
- (i) Power take-off was engaged.
- (j) Worn universal joints.
- (k) Driveshaft out of balance.
- (l) Universal joint angles out of plane or at excessive angles.
- (m) Center bearings in driveline dry, not mounted properly.
- (n) Wheels out of balance.
- (o) Tire treads humming or vibrating at certain speeds.
- (p) Air leaks on suction side of induction system, especially with turbo-chargers.

Mechanics should try to locate and eliminate noise by means other than a transmission removal or an overhaul. However, if the noise appears to be in the transmission, try to determine what position the gear shift lever is in when the noise occurs. If the noise is evident in only one gear position, the problem is generally traceable to the operating gears. Next, try to break the noise down into the following classifications:

- 
- (a) *Growling, humming and grinding.* These noises are caused by worn, chipped, rough or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.

A lack of lubricant or use of improper lubricant can also result in growling and grinding noises. This is because there is insufficient lubricant to cool and cover the gears, which allows metal-to-metal contact.

- (b) *Hissing, thumping and bumping.* Hissing noises can be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to a thumping or bumping.

- (c) *Gear whine.* This is usually caused by lack of backlash between mating gears. Improper PTO shiming is the big offender here.
- (d) *Vibration.* Today's improved highways mean entire power trains are cruising at higher RPMs. These higher speeds mean damage caused by driveline vibration is more obvious than in the past.

When the maximum RPM of a shaft is reached, it begins to bow. A resonant hum can be heard, and a vibration will be set up. This type vibration can cause gear seizures, broken synchronizer pins, bearing failures, brinelling and corrosion.

During acceleration and deceleration, the shaft may pass through half-critical vibration (half the maximum RPM of the shaft). A whine or boom may be heard at this point.

- (e) *Metallic rattles.* These noises within the transmission usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch. In heavy duty equipment, clutch discs with vibration dampers are not used, so a rattle—particularly in neutral—is common with diesel equipment.

In general, engine speeds should be 600 RPM or above to eliminate objectionable rattles and vibration during the idle. A defective or faulty injector would cause a rough or lower idle speed, and possibly a rattle in the transmission. A rattle can also be caused by excessive backlash between the PTO input gear and the transmission output gear.

**Noise in Neutral**

Possible Causes:

- (a) Misalignment of transmission.
- (b) Worn flywheel pilot bearing.
- (c) Worn or scored countershaft bearings.
- (d) Worn or rough reverse idler gear.
- (e) Sprung or worn countershaft.
- (f) Excessive backlash in gears.
- (g) Worn mainshaft pilot bearing.
- (h) Scuffed gear tooth contact surface.
- (i) Insufficient lubrication.
- (j) Use of incorrect grade of lubricant.

**Noise in Gear**

Possible Causes:

- (a) Worn or rough mainshaft rear bearing.
- (b) Rough, chipped, or tapered sliding gear teeth.
- (c) Noisy speedometer gears.
- (d) Excessive end play of countershaft gears.
- (e) Refer to conditions listed under *Noise in Neutral*.

**Oil Leaks**

Possible Causes:

- (a) Oil level too high.
- (b) Wrong lubricant in unit.
- (c) Non-shielded bearing used as front or rear bearing cap where applicable.
- (d) Seals defective, wrong type or omitted from bearing cap.
- (e) Transmission breather omitted or plugged internally.
- (f) Capscrews loose, omitted or missing from remote control, shifter housing, bearing caps, PTO or covers.
- (g) Oil drain-back openings in bearing caps or case plugged with varnish, dirt, or gasket material.
- (h) Gaskets shifted or squeezed out of position, broken gaskets with pieces still under bearing cap, clutch housing, PTO and covers.
- (i) Cracks or holes in castings.
- (j) Loose drain plug.
- (k) Oil leakage from engine.
- (l) Loose speedometer adaptor or connections.

**Walking or Jumping Out of Gear**

If the units are walking out of gear, it could be caused by:

- (a) External interference, such as the floorboard opening, preventing full engagement, *or*
- (b) An internal malfunction, such as worn clutching teeth, allowing the transmission to shift out of position.

If a remote control is being used, make sure it is functioning properly before the transmission is blamed for the problem. Note whether the unit walks out of gear under drive while pulling a load, or on a coast load. Also, notice whether the gear hop occurs on smooth roads or only on rough roads. Items that would prevent full engagement of gears are:

- (a) Improperly positioned forward remote control which limits full travel forward and backward from the remote neutral position.
- (b) Improper length shift rods or linkage that limits travel of forward remote from neutral position.
- (c) Loose bell cranks, sloppy ball and socket joints.
- (d) Shift rods, cables, etc., too spongy or flexible, or not secured properly at both ends.
- (e) Worn or loose engine mounts if forward unit is mounted to frame.
- (f) Forward remote mount too flimsy, or loose on the frame.
- (g) Set screws loose at remote control joints, on shift forks inside remote or even inside transmission unit.
- (h) Shift fork pad clips or groove in sliding gear or collar worn excessively.
- (i) Worn taper on gear clutch teeth.
- (j) Transmission and engine out of alignment either vertically or horizontally.

A few items which could move the gear or shaft out of proper position, particularly on rough roads are:

- (a) Use of heavy shift lever extensions.
- (b) Broken shift rod poppet springs.
- (c) Worn shift rod poppet notches.
- (d) Bent or sprung shift rods.
- (e) Shift fork pad clips broken or missing.
- (f) Excessive end-play in drive gear, mainshaft or countershaft, caused by worn bearings or retainers.
- (g) Worn or missing thrust washers.

## Hard Shifting

An improperly operating clutch will interfere with the proper shifting of gears in any transmission. It is also important that the hydraulic, air or similar release mechanism is in proper working order. If full and complete clutch release is being made, the following could be a few of the possible causes for hard shifting complaints:

- (a) No lubricant in remote control unit. (Note: The forward remote is isolated and is often overlooked. Many remote controls used on transmissions and auxiliaries require separate lubrication.)
- (b) No lubricant in, or grease fittings on, u-joints or swivels of remote controls.
- (c) Lack of lubricant or wrong lubricant used, causing buildup of sticky varnish and sludge deposits on splines of shaft and gears.
- (d) Badly worn or bent shift rods.
- (e) Improper adjustment on shifter linkage.
- (f) Sliding clutch gears tight on splines of shaft.
- (g) Clutch teeth burred over, chipped or badly mutilated because of improper shifting.
- (h) Binding or interference of shift lever with other objects or rods inside the cab or near the remote control island.
- (i) Driver not familiar with proper shifting procedure for the transmission, or with 2-speed axle or auxiliary.
- (j) Clutch or drive gear pilot bearing seized, rough, or dragging.
- (k) Clutch brake engaging too soon when clutch pedal is depressed.
- (l) Wrong lubricant, especially if extreme pressure type lubricant is added.
- (m) Free running gears seized or galled on either the thrust face or diameters.

## Sticking in Gear

- (a) Clutch not releasing. Also check remote units such as hydraulic or air assist. **Note:** On some units employing a full air control for clutch release, air pressure of approximately 60 lbs. or more must be secured before the clutch can be released. **Do not leave these vehicles parked in gear.**
- (b) Sliding clutch gears tight on splines.
- (c) Chips wedged between or under splines of shaft and gear.
- (d) Improper adjustment, excessive wear or lost motion in shifter linkage.
- (e) Clutch brake set too high on clutch pedal, locking gears behind hopping guards.

## Bearing Failures

The service life of most transmissions, main and auxiliary, is governed by the life of the bearings. The majority of bearing failures can be attributed to vibration and dirt. Some other prominent reasons for unit bearing failures are:

- (a) Fatigue of raceways or balls.
- (b) Wrong type or grade of lubricant.
- (c) Lack of lubricant.
- (d) Broken retainers, brinelled races and fretting caused by vibration.
- (e) Bearings set up too tight or too loose.
- (f) Improper installation resulting in brinelled bearings.
- (g) Improper fit of shafts or bore.
- (h) Acid etching due to water in lube.
- (i) Vehicle overload or too large an engine for the transmission resulting in overload.

## Dirt

More than 90% of all ball bearing failures are caused by dirt, which is always abrasive.

Dirt may enter the bearings during assembly of units, or may be carried into the bearing by the lubricant while in service. Dirt also may enter bearings through seals, the breather or even dirty containers used for addition or change of lubricant.

Softer material, such as dirt or dust, usually forms abrasive paste or lapping compounds within the bearings. The pressure between the balls and raceways makes a perfect pulverizer: The rolling motion tends to entrap and hold the abrasives. As the balls and raceways wear, the bearings become noisy. The lapping action tends to increase rapidly as the fine steel from the balls and rollway adds to the lapping material.

Hard, coarse material, such as metal chips, may enter the bearings during assembly from tools such as hammers, drifts, and power chisels. It may also be manufactured within the unit during service from raking teeth. These chips produce small indentations in balls and races. When these hard particles jam between the balls and races, it may cause the inner race to turn on the shaft, or the outer race to turn in the housing.

## Fatigue

All bearings are subject to fatigue and must be replaced eventually. Your own operating experience will dictate mileage replacement of bearings showing only normal wear.



**Corrosion**

Water, acid and corrosive materials formed by deterioration of lubricant, will produce a reddish-brown coating and small etched holes over outer and exposed surfaces of the race. Corrosive oxides also act as lapping agents.

**Shaft Fits**

Bearing fits on rotating shafts are usually specified as tight. Excessive looseness—even .001"—under a load, produces a creeping or slipping of the inner race on the rotating shaft. The result is that surface metal of the shafts scrub or wear off. The force causing the inner race to rotate disappears when the bearing fits properly.

**Installation and Removal of Bearings**

Improper installation or removal of bearings, especially hammering the bearing on the shaft with off-center blows, can result in brinelling. Since such damage is seldom visible, it does not become known until after failure or complete disassembly. The correct drivers (preferably under an arbor press) and pullers should be used.

Removing bearings is more difficult than installing them. In most cases, it is necessary to remove the bearing by pulling on the outer race, which can damage the balls or races. Therefore, it is a good idea to replace bearings during an overhaul, to prevent problems. However, if a bearing is not going to be replaced, avoid removal during low mileage rebuilds.

**Interchangeability**

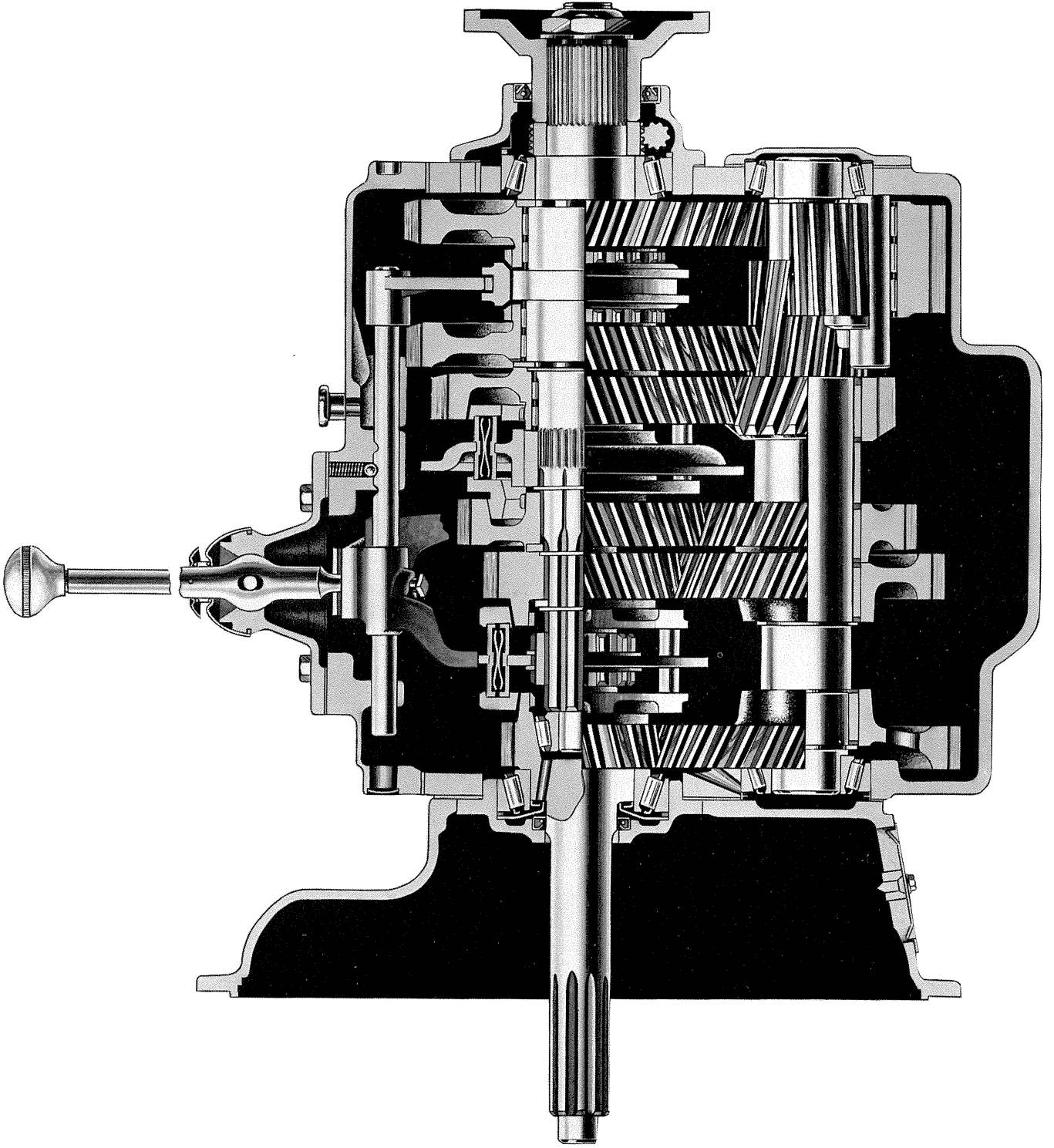
All ball bearings, whether manufactured here or abroad, are interchangeable in regard to standardized dimensions, tolerances, and fits. However, for a given shaft size there are standard bearings for light, medium, and heavy duty service.

Numbers and symbols stamped on inner and outer races of bearings designate size and type. Note that the numbering systems of different bearing manufacturers have not been standardized. Consult interchangeable tables and use the proper bearings for replacement parts.

**Clutch Troubleshooting**

Faulty clutch operation interferes with proper shifting of gears in any transmission. For complete information on Spicer clutches, refer to bulletins 1302 and 1308. If a clutch other than a Spicer is used with this transmission, refer to the manufacturer's service manual for correct adjustment and maintenance. The two following paragraphs describe the most common problems encountered with Spicer clutches.

- (a) If the clutch slips or does not engage properly, first check the internal clutch adjustment. If adjustment does not remedy the situation, check for weak pressure springs, lack of free pedal, and worn or oily clutch facings and binding release mechanism.
- (b) If the clutch drags or does not release properly, check the internal clutch adjustment. Some other causes for clutch drag are: an intermediate plate sticking on drive pins or drive lugs; the pressure plate not retracting; a distorted or warped driven disc; worn splines on the main drive gear of the transmission; a damaged clutch release bearing; or the bushing in the release sleeve may be dragging on the transmission drive gear.



ES60-5 SERIES  
CM 59 SERIES



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